MODIS SCIENCE DATA SUPPORT TEAM PRESENTATION

August 16, 1991

AGENDA

1. Action Items
2. MODIS Airborne Simulator
3. MODIS - Scheduler Assumptions
4. TEG's Status

ACTION ITEMS

05/03/91 [Lloyd Carpenter and Team]: Prepare a Level-1 processing assumptions, questions and issues list, to be distributed to the Science Team Members and the MCST for comment. (The list, the executive summary, information on the EOS Platform Ancillary Data, and a cover letter were delivered for signature and distribution.) STATUS: Open. Due date 06/07/91.

06/07/91 [Liam Gumley]: Speak to Alan Strahler, when he returns, regarding his MAS requirements. (Strahler will be contacted when he becomes available.) STATUS: Open. Due date 07/05/91

06/21/91 [Liam Gumley]: Generate a complete milestone schedule for conversion, installation and testing of all modules of the MAS Level-1B processing software at GSFC. Draw up an agreement between the SDST and Mike King of what will be done. (Updated versions of these are included in the presentation.) STATUS: Closed. Due date 07/19/91

05/31/91 [Al McKay and Phil Ardanuy]: Examine the effects of MODIS data product granule size on Level-1 processing, reprocessing, archival, distribution, etc. (Reports were provided on June 21 and 28, 1991.) STATUS: Open. Due Date 06/21/91

06/28/91 [Lloyd Carpenter and Tom Goff]: Prepare a detailed list of scheduler assumptions in relation to Level-1 MODIS processing scenarios. (An updated list is included in the presentation.) STATUS: Open. Due date 07/26/91.

ACTION ITEMS FROM SDST MEETING 26 July 1991 [Liam Gumley]

(1) Contact Alan Strahler to discuss his requirements for MAS processing.

I called Boston University again and they confirmed that Strahler will be out of the country until about August 26. A message has been left asking that he contact me when he returns.

(2) Update the draft agreement between the SDST and Mike King describing the work the SDST will perform in support of the MAS Level-1B data processing.

Changes suggested in the 07/26/91 meeting have been made, and a draft is included. A copy was faxed to Mike King, and he promised to review it in conjunction with Paul Menzel. I have talked to King and Menzel since then and they both are satisfied with the document as it stands.

(3) Draft a biweekly milestone schedule for the MAS Level-1B data processing system development.

A current milestone (GANTT) chart is included.

(3) Report current progress on MAS Level-1B data processing system development.

An update on progress is included.

DRAFT

MODIS Science Data Support Team

Development of a MODIS Airborne Simulator Level-1B Processing System

15 August 1991

Introduction

The MODIS Science Data Support Team (SDST) has been given the task of implementing a MODIS Airborne Simulator (MAS) Level-1B Processing System at Goddard Space Flight Center (GSFC). This document describes the components of the task and outlines the methodology that will be used in the completion of the task.

Summary

The task is to develop a system at GSFC which will ingest Level-1A MAS data, perform calibration and geolocation, and write the resulting Level-1B data in a common format. An existing commercial imaging package will be utilized to allow users at GSFC to view MAS imagery. Support will be provided for archiving and distributing the data to users.

History

The MAS will be developed from an existing aircraft scanner, the Daedalus Wildfire. This instrument shares a common heritage with the NASA Multispectral Atmospheric Mapping Sensor (MAMS). Both instruments fly on board the NASA ER-2. Methods to calibrate and geolocate MAMS data have been developed at the Cooperative Institute for Meteorological Satellite Studies (CIMSS), University of Wisconsin-Madison. The methods developed at CIMSS for calibration and geolocation of MAMS data will be used for the processing of MAS data, which shares common characteristics with the MAMS.

Level-1A data ingest

The MAS Level-1A data will be obtained from Ames Research Center (ARC) in raw form (no calibration or earth location). MAS data will be obtained as soon as possible after flight missions to enable rapid processing and distribution. Processing of the MAS Level-1A data will take place at GSFC.

Calibration

The infrared bands of the MAS in a given scanline will be calibrated using the blackbody data from that scanline only - no averaging of blackbody data will be done. The visible and near-infrared bands of the MAS will be calibrated using pre and post launch calibration data provided by ARC. These methods are used operationally by CIMSS for calibrating MAMS data, and are described in NASA Technical Memorandum 100352 "Improved Capabilities of the Multispectral Atmospheric Mapping Sensor (MAMS)".

Geolocation

Geolocation of the MAS data requires the use of the ER-2 Inertial Navigation System (INS) data supplied by ARC. Geolocation will be done on a straight line flight track basis. Straight line flight tracks are determined by inspection of the change in aircraft heading with time. Linear regression relationships are then developed for aircraft nadir

latitude and longitude, heading, altitude etc. for each straight line flight track. Pixels in that flight track are then geolocated using aircraft positions derived from the regression relationships. This method is used operationally by CIMSS to geolocate MAMS data and is also described in NASA Technical Memorandum 100352.

In order to keep the geolocation data down to a manageable size, every tenth pixel on a scanline will be geolocated. Each of these pixels will have latitude, longitude, sensor zenith angle, sensor azimuth angle, solar zenith angle and solar azimuth angle computed. A simple cubic spline algorithm can then be used to interpolate the geolocation data across the scanline. FORTRAN code to compute cubic splines will be supplied.

Level-1B output data

The Level-1B output data will contain calibrated MAS radiances for every pixel on every scanline and geolocation data for every tenth pixel on every scanline. It will also contain all the instrument data (except raw image data) that was included in the Level-1A data set, as well as the ER-2 INS data for that flight. Only straight line flight track portions of the flight will have valid geolocation data, however calibrated radiances will be included for all portions of the flight, including aircraft turns. Information detailing the start and end of the straight line flight track portions of the data will be supplied.

The MAS Level-1B data will be supplied to users in the Hierarchical Data Format (HDF) developed by the National Center for Supercomputing Applications (NCSA).

MAS image viewing

An existing imaging software package (EASI/PACE) will be used to enable users at GSFC to view MAS imagery on a Silicon Graphics workstation, located in the Laboratory for Terrestrial Physics (Code 920). An interface will be developed to allow MAS image data to be read by EASI/PACE. Users will be able to view MAS image data in subsampled, uncalibrated form, with no geolocation information. This is intended to allow users to identify areas of interest in a MAS flight mission such as land/ocean boundaries or clouds. It is not intended to serve as a source of MAS image data.

Data archiving and distribution

An archive of the MAS Level-1A data will be maintained at GSFC, as well as an archive of processed Level-1B data. Users will be able to order data from MAS flights on either magnetic tape, or by electronic transfer via Internet.

Schedule

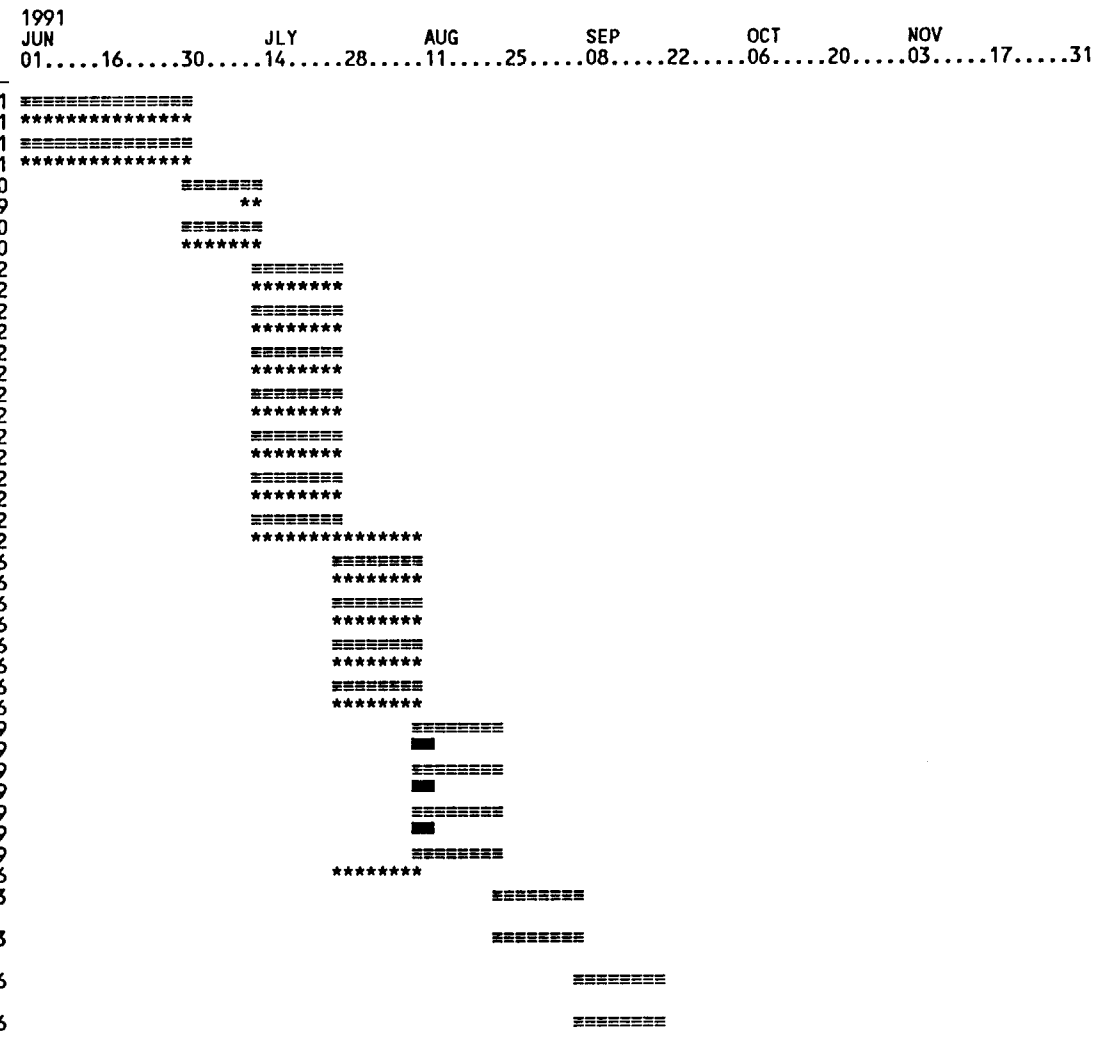
Current planning is for the first MAS flight to occur on November 18, 1991. It is planned to have the MAS Level-1B processing system operational by this time.

Date: 08/15/91
Each Symbol = 2 Days

MAS Level-1B Processing System
MAS01

≡ Planned
■ Actual
* Completed
M Milestone

MAS Level-1B Processing System Development at GSFC



Task	Resource/Status	Date
MAS data user requirements survey		06/01
	LG C	06/01
Investigate hardware requirements		06/01
	LG C	06/01
Visit Wisconsin to obtain code/data		06/30
	LG C	07/09
Specify contents of Level-1B output		06/30
	LG C	06/30
Obtain accounts on LTP VAX and IRIS		07/12
	LG C	07/12
Transfer MAMS source code to VAX		07/12
	LG C	07/12
Transfer MAMS/INS data to VAX		07/12
	LG C	07/12
Decode INS data file		07/12
	LG C	07/12
Get straight flight tracks from INS		07/12
	LG C	07/12
Find regressions of heading vs time		07/12
	LG C	07/12
Investigate PCI software on IRIS		07/12
	LG C	07/12
Write code to compute regressions		07/26
	LG C	07/26
Write code to unpack 8-bit imagery		07/26
	LG C	07/26
Write code to get straight imagery		07/26
	LG C	07/26
Display 8 bit imagery on PC, IRIS		07/26
	LG C	07/26
Examine MAMS calibration code		08/09
	LG I	08/09
Develop calibration modules, driver		08/09
	LG I	08/09
Test calibration against MAMS data		08/09
	LG I	08/09
Prepare subsampled data for IRIS		08/09
	LG C	07/26
Examine MAMS geolocation code		08/23
	LG	
Develop geolocation modules, driver		08/23
	LG	
Test geolocation against MAMS data		09/06
	LG	
Integrate calibration, geolocation		09/06
	LG	

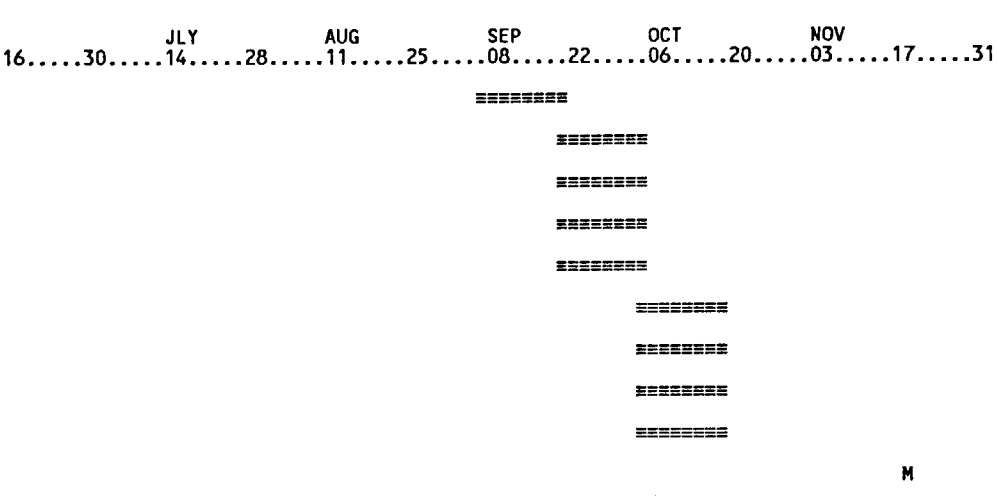
Date: 08/15/91
Each Symbol = 2 Days

MAS Level-1B Processing System Development at GSFC

MAS Level-1B Processing System
MAS01

≡ Planned
■ Actual
* Completed
M Milestone

Task	Resource/Status	Date
Introduce users to IRIS imagery	LG	09/06
Integrate Level-1B into HDF (TEG)	LG	09/20
Process new MAMS data set	LG	09/20
Fix any bugs found	LG	09/20
Incorporate any changes from users	LG	09/20
Integrate documentation, user guide	LG	10/04
Create HDF output, write to tape	LG	10/04
Test HDF read/write routines (TEG)	LG	10/04
Confirm MAS delivery with Ames	LG	10/04
First MAS flight for FIRE	LG	11/18



Progress on MAS Level-1B processing system development

Progress up to 2 August 1991

Considerable effort has been directed at unpacking the various items contained in the Ames Level-1A MAMS data. This contains both instrument engineering data, and video data for the 12 instrument channels.

Code has been developed to extract the engineering and 8-bit video data for a given channel from any scanline in a Level-1A data file. Code to produce simple imagery of the video data has been developed to enable checking of the video data integrity.

The MAMS data supplied on the test tape covers the time period from 12.995 hours (1300) to 14.236 hours (1414). Total flight time was from 1300 to 1530 (determined from INS data). Chris Moeller at Wisconsin will be contacted to organize the delivery of the rest of the dataset.

The MAMS data on the test tape contains the first two of the ten straight line flight tracks identified from the INS heading data. These flight tracks are

(1)	13.52 hr	to	13.76 hr
(2)	13.83 hr	to	14.25 hr.

Subsampled images of MAMS band 5 (0.66 microns) were created and downloaded to an IBM-PC where they were viewed using IMDISP. The image data appears to be of good quality, and considerable cloud cover is evident.

Progress up to 15 August 1991

The routines to unpack video data from the MAMS Level-1A dataset have been updated to accommodate 10 bit data. The extra two bits can be in any position in any channel, and the positioning can be updated interactively in a channel configuration file. Chris Moeller was contacted to confirm the ordering of the bit pairs within the "bit bucket". He confirmed that the MAMS configuration has the least significant two bits from channels 9 to 12 packed from left(MSB) to right(LSB) in channel 1. This is expected to change in the MAS configuration. I also asked Chris to send us the rest of the MAMS test data set within the next couple of weeks.

A demonstration of the PCI imaging software on the IRIS was provided by Jon Burelbach (MCST). Using a subsampled MAMS test image it was possible to display a grey-scaled image without problems. All the steps needed to display the imagery were covered in this demonstration, and it appears to be a simple task to adapt the MAMS data for this purpose. The IMDISP imaging program on the PC has also been used for MAMS image display, and this may be worthwhile to investigate as an image viewing capability for users outside GSFC.

Development of the calibration modules is underway. Initial effort has been directed at the calibration of the thermal infrared channels. This requires the computation of Planck radiances for the MAMS channels, and this requires information on the spectral bandpass characteristics of the infrared channels. Spectral bandpass data for the MAMS was obtained from Wisconsin, however the data has not yet been obtained for the MAS infrared channels. I am keeping in touch with Chris Moeller, Paul Menzel and Mike King to find out when they will become available.

Code has been developed to compute Planck radiances and equivalent brightness temperatures for the MAMS channels. These are being tested against the MAMS calibration values supplied by Wisconsin. The calibration methodology developed at Wisconsin is being followed, which involves careful checking of the instrument black body temperatures and radiance counts for any anomalies. The test data examined so far shows no major problems in this regard.

Code has been developed to compute linear regressions for the parameters contained in the ER-2 INS data. This code will be used in the geolocation computations for straight line flight tracks.

MODIS LEVEL-1A AND LEVEL-1B PROCESSING INTERFACES WITH EOSDIS SCHEDULING, CONTROL, AND ACCOUNTING (SCA) ASSUMPTIONS

(PRELIMINARY)

August 16, 1991

The assumptions in this list relate to the interface between the MODIS Level-1 science data processing and the EOSDIS scheduler (referred to as the SCA (Scheduling, Control and Accounting) in this document). Not all of the EOSDIS Core System (ECS) functions have been specified in detail, so these assumptions must be considered preliminary. The numbering of items comes from a master list being tracked by the MODIS Science Data Support Team. Only those items which relate to the SCA interface are included in this abbreviated list.

SCA Interface (057). The SCA interfaces with the MODIS Level-1A and 1B processing systems in two ways: 1) it serves as control to the MODIS system (it sends messages to the MODIS system) and 2) it receives processing status information (it receives messages from the MODIS system).

SCA Control of the MODIS Level-1A and 1B Processes (058). The SCA controls the MODIS Level-1A and 1B processes through a system of messages as follows:

> Initiate Execution: The SCA sends an Initiate Execution message to the MODIS system to begin processing. The message contains information on the data to be processed, including file names (or other pointers) indicating the location of the MODIS input data (Level-0 data and the associated ancillary data for Level-1A processing, or Level-1A data for Level-1B processing).
>
> Suspend Execution: The Suspend Execution message tells the MODIS system to stop processing without enacting shutdown procedures (e.g., don't close data files). No response message is sent to the SCA. The Suspend Execution message should eventually be followed by either a Resume Execution message or a Cancel Execution message.
>
> Resume Execution: The Resume Execution message, which follows a Suspend Execution message tells the MODIS process to pick up where it left off and continue processing.
>
> Cancel Execution: The Cancel Execution message tells the MODIS process to terminate processing. The contents of the message indicate an abort termination or a

graceful termination. The MODIS process returns a post-processing message indicating that the requested termination has been performed. The MODIS process can then be removed from memory or restarted as necessary. A restart following an abort termination requires an Initiate Execution message, while a graceful termination message is usually followed by a Resume Execution message.

Dynamic Status Request: The Dynamic Status request is a message sent to the MODIS Level-1A or 1B system indicating that a dynamic status response message is to be generated. The MODIS system looks for the presence of the Dynamic Status request at selected points in the processing by interrogating the operating system. When the request is present, the MODIS process generates a Dynamic Status Response giving the current status of the processing. See "Dynamic Status Response" under the paragraph "MODIS Level-1A and 1B Reports to the SCA".

Select Processing Mode: The Select Processing Mode message is generated before the Initiate Execution message to specify the type of MODIS Level-1A or 1B processing to be done, i.e., standard, reprocessing, or quick-look.

MODIS Level-1A and 1B Reports to the SCA (059). The MODIS Level-1A and 1B processing systems send reports of processing performance and fault conditions to the SCA as follows:

Post-Processing Report: The Post-Processing Report is the final accounting message sent to the SCA by the MODIS process to indicate the termination status. The report is posted to the operating system for retrieval by the SCA upon termination of the MODIS process. The report contains the file name (location) of the output data granule and metadata products, an indication of the quality of the processing (criteria to be determined), and an indication of the quantity (size) of the data produced.

Dynamic Status Response: The Dynamic Status Response is the MODIS system response to a Dynamic Status Request message from the SCA. It contains the information necessary for the SCA to determine the current MODIS Level-1A or 1B processing status. An indication of data quality may also be included.

For MODIS Level-1A, this includes the number of packets expected and already processed, spacecraft (S/C) start and stop times of the completed packets, an estimate of the percentage of granule completion, and an indication of the quantity of data already processed.

For MODIS Level-1B, the response includes the number of Level-1A input granules expected and already processed, spacecraft (S/C) start and stop times of the completed granules, and an estimate of the percentage of completion of the scheduled processing.

Alarm: An Alarm is an unsolicited message from the MODIS system to the SCA indicating that a serious problem has occurred within the MODIS system that could

lead to generation of invalid data. The contents of this message indicate the nature and severity of the problem. The message is expected to have indicator flags (predefined error values) as well as a character-based message for operator display.

Event: An Event is another unsolicited message from the MODIS system to the SCA. The Event message contains indicator flags (the meaning of which are pre-determined) for anomalies in the telemetered data. An Event represents a non-catastrophic occurrence and does not indicate a serious problem with the processing.

MODIS Processing Modes (060). The SCA will initiate execution of MODIS Level-1A and 1B processing in the following modes:

1) MODIS Level-1A standard processing

2) MODIS Level-1A quick-look processing

3) MODIS Level-1A reprocessing

4) MODIS Level-1B standard processing

5) MODIS Level-1B quick-look processing

6) MODIS Level-1B reprocessing

7) MODIS Level-1B standard browse data processing

It is assumed that the metadata are generated at the same time as the data products so that no separate scheduling is required for this purpose.

Initiating Execution of Level-1A or 1B Standard Processing (061). Before sending an Initiate Execution message to the MODIS Level-1A or 1B process for standard processing, the SCA will determine that the pertinent input data are available. This will include MODIS instrument data and platform ancillary data for Level-1A processing and Level-1A data for Level-1B processing. Data status tables for this purpose will be kept by the SCA.

All of the data required for Level-1B processing will be contained in the Level-1A product.

Data status tables must be kept by either the MODIS process, the SCA process or possibly another EOSDIS process, such as the IMS.

Level-1A Data Granules (062). Normal MODIS Level-1A processing will generate an integer number of complete Level-1A granules. If the time boundaries of the data interval scheduled for processing do not fall on normal Level-1A granule boundaries, then the

MODIS Level-1A process will include the additional data required to complete the granules, if the additional data are available. If the additional data are not available, the MODIS Level-1A process will reduce the scheduled interval to eliminate the partial granules at the beginning and/or end of the interval. This adjustment will be indicated in the Post-Processing Report and the MODIS Processing Log. Upon completion of the process, the SCA will update the data status tables to show which Level-0 data have been processed to Level-1A

> This procedure eliminates the situation where the data in a Level-1A granule is not all generated in the same run. Without this constraint it is even possible that data within a granule could be processed using more than one version of the software.

Level-1B Data Granules (063). Normal MODIS Level-1B processing will generate an integer number of complete Level-1B data granules. Whether or not there is a one-to-one correspondence between the Level-1A and 1B data granules, it is assumed that the Initiate Execution message from the SCA for standard Level-1B processing will specify an integer number of complete Level-1B granules to be generated, and that the required Level-1A input granules will be unambiguously specified.

Initiating Execution of Level-1A or 1B Quick-Look Processing (064). Before sending an Initiate Execution message to the MODIS Level-1A or 1B process for quick-look processing, the SCA will determine that the pertinent input data are available. This will include MODIS instrument data and platform ancillary data for Level-1A processing and Level-1A data for Level-1B processing.

> For quick-look processing, all of the data specified in the Initiate Execution message will be processed without regard to normal granule boundaries.
>
> The MODIS Level-1 process will notify the SCA when the processing is complete through the Post-Processing Report.

Initiating Execution of MODIS Level-1A and 1B Reprocessing (065). MODIS reprocessing at Level-1A will be the same as standard processing except that it may use either the Level-0 data or the previously generated Level-1A data as input. The SCA will specify which type of input data will be used, and will indicate the location through the Initiate Execution message. MODIS reprocessing at Level-1B will be the same as standard Level-1B processing. An adequate scheme will be provided for distinguishing between different versions of the data products.

MODIS Level-1B Standard Browse Data Processing (066). If the MODIS Science Team has a requirement for a standard Level-1B browse product, it is assumed that the required processing will be scheduled to automatically follow the Level-1B standard processing.

Tom Goff's Status
for
15 August, 1991

TGoff on GSFC mail, or teg@LTPIRIS2.GSFC.NASA.GOV

- HDF files are downloaded to LTPIRIS2. They are accessible to anyone via anonymous FTP to LTPIRIS2, in the directory /pub/HDF (case sensitive). The source files have been compiled via the MAKE.IRIS4 script with an "ignore" option because this computer does not have a FORTRAN compiler. The HDF library can therefore be used with C programs only!

- HDF files have been moved to the LTP VAX cluster and have been successfully compiled. Users wishing to compile the VAX version of HDF must use the source files as contained on this VAX. These files are newer than the normal distribution and have had the bugs exorcised.

- Cadre's TeamWork uses floating seats for all products. This means that many people can use the product on one seat but only one at a time.

- We have ordered a 9600 V.42bis modem for RDC to be shipped 12 August. This will allow one of use to access the GSFC modem pool at high speed. This modem will be used for PC based TCP/IP in the near future and Xwindows down the line (hopefully) as a precursor to a faster network implementation.

- Still chasing down SoftBench on SGI machines. The CDC licensee for SoftBench on MIPS 300 architectures (SGI included) has indicated that CDC is currently porting SoftBench to CDC machines and will consider SGI's in the future. HP says that Informix is also a SoftBench licensee for SGI architecture machines.

- RCD will verify GSCF V.42bis capability for TCP/IP and terminal uses with the above mentioned modem when it arrives.

- RCD is examining X.Window alternatives on PC's (DOS and/or UNIX) and the Macintosh to provide a better method for accessing the various GSFC machines.

- Information is pending for the Analyst Configuration Management (CM) product.

- We are considering the separation of the Level-1B design into separate anchor point and calibration sections to allow MCST delays to not affect anchor point determination. This separation allows the two sections to be processed in parallel!

- HDF - needs enhancements to the existing data set types to include 10 bit (alias 16 bit) raster images, anchor point spatial placement, INS or other ephemeris tagging, and metadata pointers (this may be included in the Vset enhancements). **This is being examined and needs to be discussed!**